An Overview of Columbia River Predation Studies

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Fish assemblages in the lower Columbia and lower Snake rivers have been shaped by numerous exotic species introductions and extensive habitat alteration associated with hydropower development (Poe et al. 1994). Many introduced species such as centrarchid and ictalurid spp. have inhabited the basin for nearly a century, whereas others like walleye *Stizostedion vitreum vitreum* have become established more recently. Potential interactions between endemic and introduced species are undoubtedly complex and innumerable, and the consequences for the distribution and abundance of native fish populations are unknown.

What is known about the habits and potential impacts of exotic piscivorous fishes was largely derived from three research projects conducted in the lower Columbia Basin over the past 20 years. A review of their major findings is requisite to any consideration of management strategies aimed at minimizing the impacts of exotic fishes in the basin. The first was conducted in 1979 - 1981 by Oregon State University (Hjort et al. 1981). The primary research objectives included measuring distribution and abundance of various habitat types in John Day Reservoir, and quantifying habitat use by life stages of all fish species. Limited sampling was also conducted in Bonneville and The Dalles reservoirs. This project was notable in the lower Columbia Basin because it examined habitat and life history characteristics of nongame and game species.

After analysis of many physical and chemical variables in John Day Reservoir, Hjort et al. (1981) found that fish habitats were mainly distinguished by differences in velocity and depth. This is most apparent when contrasting the reservoir forebay (deep with slow water velocity) with the tailrace (relatively shallow with fast velocity), but also main channel versus backwater habitats. Backwaters were important spawning, rearing, and adult feeding areas for many exotic species. In contrast, native species including white sturgeon *Acipenser transmontanus*, mountain whitefish *Prosopium williamsoni*, and most cyprinids were associated with fast water in or near the tailrace, particularly for spawning. This generalization between exotic and native habitat associations probably holds true for other mainstem reservoirs, most of which have fast water exchange rates and small littoral zones that limit phytoplankton and zooplankton production.

A second extensive research study was conducted in John Day Reservoir from 1983-1986 to quantify impacts of resident fish predation on juvenile salmonids *Oncorhynchus* spp. The project targeted four predator species; northern pikeminnow *Ptychocheilus oregonensis* (known as northern squawfish prior to 1998; Nelson et al. 1998), smallmouth bass *Micropterus dolomieu*, walleye, and channel catfish *Ictalurus punctatus*. Major findings included predator distributions and abundance (Beamesderfer and Rieman 1991), population statistics (Beamesderfer and Rieman 1988), diets (Poe et al. 1991), and consumption rates on juvenile salmonids (Vigg et al. 1991).

Estimates of numerical losses of juvenile salmonids to each predator species showed that northern pikeminnow accounted for 78% of the losses attributable to resident predators, walleye accounted for 13%, and smallmouth bass accounted for the remaining 9% (Rieman et al. 1991). Northern pikeminnow were considered the major resident predator species by virtue of their opportunistic food habits, greater abundance relative to the other species, and their prevalence in the upper part of the reservoir where juvenile salmonids were considered most vulnerable. Smallmouth bass were most common in the lower part of the reservoir where their impact was largely restricted to summer-migrating chinook salmon *O. tshawytscha*. Walleye consumption of juvenile salmonids exceeded that of smallmouth bass, but their impact was limited by their low abundance in the reservoir. Predation by channel catfish was not estimated because of difficulties associated with determining their abundance in John Day Reservoir, although diet analysis showed that juvenile salmonids were commonly preyed upon by channel catfish.

The results of the predation study in John Day Reservoir led to the implementation in 1990 of the Northern Pikeminnow Management Program throughout the mainstem lower Columbia and lower Snake rivers, with the intent to enhance juvenile salmonid survival by selectively harvesting northern pikeminnow (Beamesderfer et al. 1996; Friesen and Ward, in press$_a$). The program was largely based on a population model developed by Rieman and Beamesderfer (1990). The model showed that population characteristics of northern pikeminnow were such that relatively modest but sustained reductions in their numbers result in a disproportionate benefit in juvenile salmonid survival. Predation management also grew out of a realization that juvenile salmonid mortality attributed to predation could be similar in magnitude to mortality associated with dam passage.

The Oregon Department of Fish and Wildlife's evaluation of the Northern Pikeminnow Management Program from 1990 through 1996 expanded the scope of predation research beyond John Day Reservoir to the entire lower and mid-Columbia and lower Snake rivers. Ward et al. (1995) showed that northern pikeminnow predation on juvenile salmonids was significant throughout the basin. Size selective harvest of northern pikeminnow has reduced the abundance of large individuals that exhibit the highest consumption rates on juvenile salmonids (Knutsen and Ward, in press; Zimmerman and Ward, in press). To date, predation by surviving northern pikeminnow and other predator species has not increased as a consequence of the predator control program (Ward and Zimmerman, in press; Zimmerman, in press).

The impact of introduced predators varies spatially throughout the basin, seasonally, and annually as a function of population abundance and variation in recruitment. Smallmouth bass are distributed systemwide, but their density increases in an upriver direction in the Columbia River and reaches a maximum in Lower Granite Reservoir in the Snake River (Zimmerman and Parker 1995). This is in direct contrast to northern pikeminnow which are most abundant downstream from Bonneville Dam and least abundant in the lower Snake River (Ward et al. 1995). Therefore, the relative impact of smallmouth bass predation is greater in the Snake River than was originally estimated in John Day Reservoir, assuming similar consumption rates between areas.

Consumption rates of smallmouth bass do not exhibit the marked increase with predator size that is characteristic of northern pikeminnow (Vigg et al. 1991), and past studies may have underestimated the impacts of smallmouth bass by restricting estimates of predation to individuals exceeding 200 mm fork length. Smallmouth bass consume smaller juvenile salmonids than northern pikeminnow at the same times and locations (Zimmerman, in press). Consequently, smaller wild stocks of chinook salmon are more vulnerable to smallmouth bass predation than larger hatchery stocks.

Walleye are distributed throughout the lower Columbia River, and appeared to be absent in the Snake River upstream from Ice Harbor Dam (Zimmerman and Parker 1995). However, several young walleye were captured in Lower Monumental Reservoir by an Oregon Department of Fish and Wildlife crew while electrofishing in 1998. Walleye abundance in the basin is driven by wide swings in year class strength and subsequent recruitment. Walleye abundance may have doubled in John Day Reservoir from the mid-1980's to the early 1990's based on year class strength analyses and sport harvest rates (Tinus and Beamesderfer 1994, Friesen and Ward, in press), and the original assessment of walleye predation relative to other predators was made during a period of low walleye abundance.

The relative magnitude of channel catfish predation on juvenile salmonids remains unknown. However, their impact on Snake River stocks may be significant because channel catfish abundance is far greater in lower Snake River reservoirs than Columbia River reservoirs (Zimmerman and Parker 1995). A thorough study of channel catfish abundance and consumption is needed to assess the impacts of their predation on juvenile salmonids throughout the basin.

While most of the region's attention regarding introduced fishes is directed toward potential losses of juvenile salmonids, the impacts of exotic predators extend to many other endemic fish and invertebrate prey populations. There is considerable overlap in the adult diets of the four predator species. Crayfish are important prey for all species, with the exception of walleye (Poe et al. 1991;). Cottids, cyprinids, catostomids, and sand rollers *Percopsis transmontana* are preyed upon by smallmouth bass and walleye to a much greater extent than by northern pikeminnow (Zimmerman, in press). Predation research has improved our understanding of introduced fish species in the lower Columbia Basin, and has raised many more questions. To what extent are northern pikeminnow diets a consequence of the presence of exotic predator species? What are the combined impacts of predators on prey populations, particularly uncommon ones such as sand rollers? What are the interactions among younger-aged native and exotic species and their fish and invertebrate prey? What factors regulate the distribution and abundance of exotic species in the basin?

Regarding the latter question, water temperatures in the Columbia and Snake rivers are generally cooler than the physiological optima for each species. Angling mortality on smallmouth bass and walleye appears modest relative to lakes and rivers in other parts of the country (Beamesderfer and Ward 1994; Tinus and Beamesderfer 1994). Habitat quality, quantity, reservoir productivity, and flow regimes in the Columbia Basin appear to regulate populations of smallmouth bass, walleye, and probably many other introduced warmwater species more than fishing mortality. Variation in spill, reservoir levels, and associated water temperatures probably limit their abundance by regulating recruitment, growth, and survival. Loss of backwater habitats as a result of proposed reservoir drawdowns may greatly reduce populations of exotic species.

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